A STUDY OF RECENT AND SEMIFOSSIL CORALS OF JAPAN : 1. Antillia and 2. Caulastraea

A STUDY OF RECENT AND SEMIFOSSIL CORALS OF JAPAN

1. *Antillia* and 2. *Caulastraea*

BY

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With 3 Plates, and 1 Text-Figure

PREFACE

A preliminary study of the greater part of the present material of the corals belonging to the genus *Antillia* together with many other forms, has been made by Mr. SHINJIRÔ HANADA, a graduate of our Institute of Geology and Palaeontology, whom we have to thank for his labour.

In the report entitled "On the So-Called Coral Bed of Noma, Province of Awa (MS.)" (1930), he illustrated the following forms of corals from the raised coral bed of Noma near the shore of Tateyama-wan:

Stylophora pistillata M.-EDW. and H.
Antillia cfr. *infundibuliformis* GERTH
Antillia lonsdaleia DUNCAN
Antillia constricta BRÜGGEMANN var. *maldivensis* GARDINER
Hydnophora exesa (PALLAS)
Hydnophora cfr. *exesa* (PALLAS)
Hydnophora sp.
Maeandra sp.
Thecosmilia? sp.
Favia pallida (DANA)
Favia speciosa (DANA)
Favites virens (DANA)
Favites cfr. *abdita* (E. and S.)
Orbicella cfr. *annuligera* (M.-EDW. and H.)
Cyphastrea sp.
Echinopora sp. nov.
Echinopora sp.
Leptastraea purpurea (DANA)
Fungia fragilis (ALCOCK)
Fungia sinensis M.-EDW. and H.
Podobacia elegans VAN DER HORST
Podobacia lobata VAN DER HORST
Podobacia sp.
Pavona danai (M.-EDW. and H.)
Psammocora cfr. *wyckoffi* VAUGHAN and HOFFMEISTER
Psammocora sp.
Coscinaraea sp.
Acropora angulata (QUELCH)
Turbinaria peltata BERNARD
Turbinaria auricularis (BERNARD)
Goniopora djiboutiensis VAUGHAN

His *Antillia* cfr. *infunduliformis* is a juvenile specimen of *Antillia constricta* BRÜGGEMANN; *Antillia lonsdaleia* is separated into *Antillia japonica* nov. and *Antillia nomaensis* nov. in the present article; and *Antillia constricta* var. *maldivensis* is our *Antillia constricta*.

His *Thecosmilia?* sp. the generic determination of which troubled him very much is now found to belong to the genus *Caulastraea* of J. D. DANA, as is stated in the second part of the present article.

Prior to his work, Dr. M. YOKOYAMA undertook a provisional determination of the semi-fossil corals of Noma. In his short note published in the Journal of the Geological Society of Tôkyô, Vol. XI, 1904, p. 105, the following genera are recorded; *Stylophora*, *Antillia*, *Montlivaultia*, *Thecosmilia*, *Heliastraea*, *Solenastraea*, *Isastraea*, *Fungia*, *Sandalolitha*, *Madrepora*, *Goniopora*,

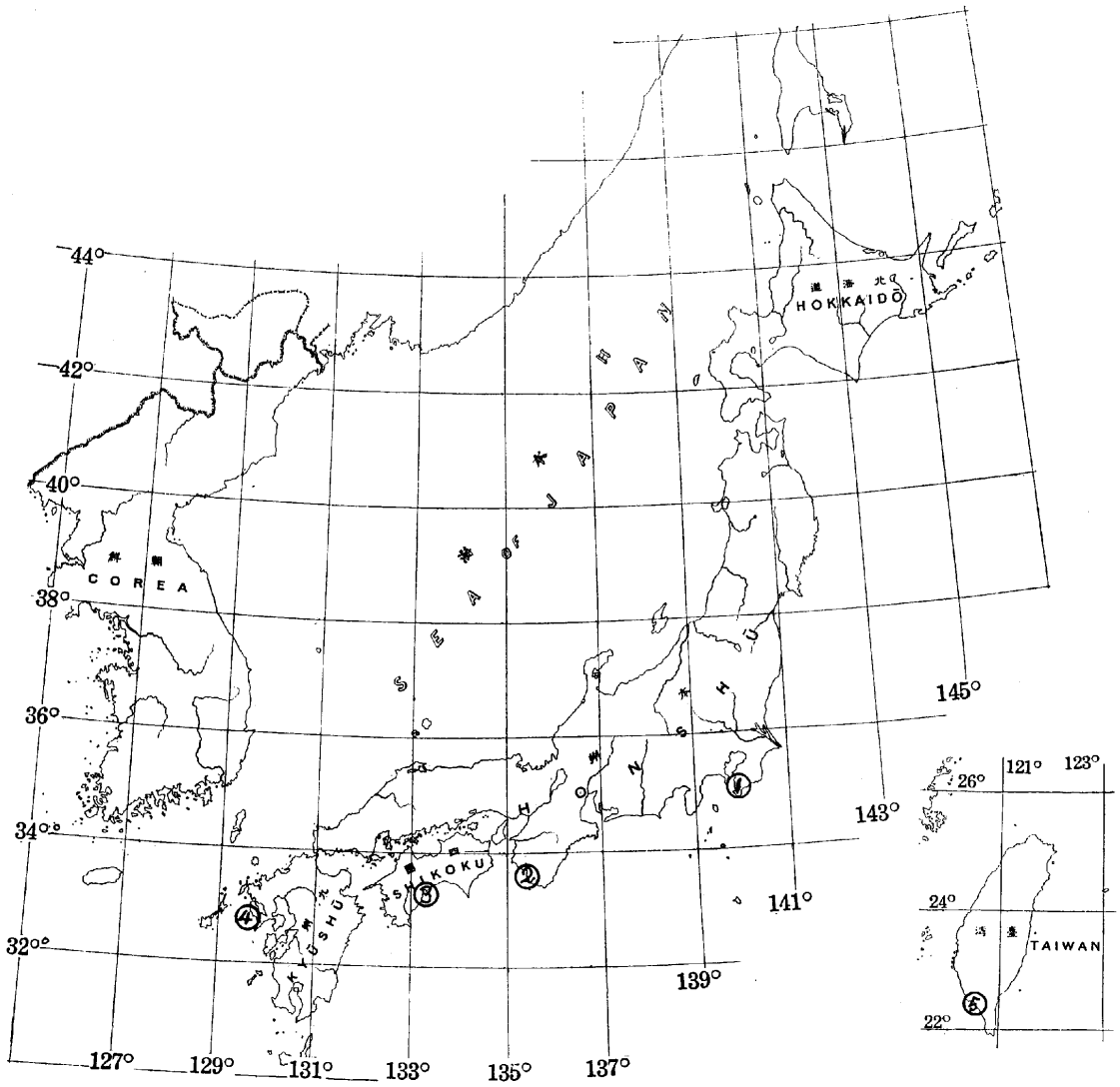
Alveopora and *Millepora*, whereas in his well known paper, "Climatic Changes in Japan since the Pliocene Epoch,"[1] it is stated "As to the corals which are found together with these shells I have not yet been able to determine their species; but this much is certain that there are true reef-building corals belonging to such genera as *Heliastraea, Cyphstraea, Prionastraea, Musa, Goniopora, Stylophora, Alveopora, Domoseris, Madreɔpora,* several genera of Fungidae etc., all of which we do not find now living north of the Riukius (the northernmost is 28° 20′ N. L.) or of the Bonins (about 27° N. L.)."

Revised and Enlarged List of Semifossil Corals from Noma

(Genera alphabetically arranged)

1. *Acanthastraea* (?) cfr. *hemprichii* (EHRENBERG)
2. *Acropora* cfr. *angulata* (QUELCH)
3. *Antillia constricta* BRUG.
4. *Antillia jɪponica* YABE and SUGIYAMA sp. nov.
5. *Antillia nomaensis* YABE and SUGIYAMA sp. nov.
6. *Antillia* sp. nov. (A)
7. *Antillia* sp. nov. (B)
8. *Alveopora* sp. (*A.* cfr. *verrilliana* DANA)
9. *Caulastraea yokoyamai* YABE and SUGIYAMA sp. nov.
10. *Caulastraea yokoyamai* var. *gracilis* Y. and S.
11. *Coscinaraea* sp. nov.
12. *Coscinaraea* sp. nov.
13. *Cyphastraea serailia* (FORSKAL)
14. *Echinophyllia* sp.
15. *Echinophyllia*? sp. nov.
16. *Favia magnistella* M.-EDW. and H.
17. *Favia pallida* (DANA)
18. *Favia speciosa* (DANA)
19. *Favites* cfr. *abdita* (ELL. and SOLL.)
20. *Favites virens* (DANA)
21. *Favites*? sp.
22. *Fungia fragilis* VAUGHAN
23. *Fungia sinensis* (M.-EDW. and H.)
24. *Hydnophora exesa* (PALLAS)
25. *Hydnophora* cfr. *exesa* (PALLAS)
26. *Hydnophora* sp.
27. *Goniopora* cfr. *djiboutiensis* VAUGHAN
28. *Leptastraea purpurea* (DANA)
29. *Maeandra* sp. (A)
30. *Maeandra* sp. (B)
31. *Montipora* cfr. *ramosa* BERNARD
32. *Montipora* sp.
33. *Orbicella curta* DANA
34. *Orbicella* cfr. *felixi* GERTH
35. *Pavona danai* (M.-EDW. and H.)
36. *Pavona* sp.
37. *Pocillopora* cfr. *cespitosa* (DANA)
38. *Podabacia elegans* M.-EDW. and H.
39. *Podabacia lobata* VAN DER HORST
40. *Podabacia nomaensis* YABE and SUGIYAMA sp. nov.
41. *Porites* cfr. *bernardi* VAUGHAN
42. *Porites* cfr. *hawaiensis* VAUGHAN
43. *Psammocora japonica* sp. nov.
44. *Psammocora superficialis* GARDINER
45. *Psammocora profundacella* GARDINER
46. *Stylophora* cfr. *pistillata* M.-EDW. and H.
47. *Stylophora* cfr. *pisutillata* (ESPER)
48. *Tridacophyllia* sp.
49. *Turbinalia auricularis* BERNARD
50. *Turbinalia* cfr. *auricularis* BERNARD
51. *Turbinalia peltata* (ESPER)

[1] M. YOKOYAMA: Journal of the College of Science, Imp. Univ. of Tôkyô, Vol. XXXII, Art. 5, 1911, p. 8.



Text-Figure I.

Outline map of the Japanese Islands showing the approximate positions of the localities of recent and semifossil corals of Japan described in this article.

1. Noma near Tateyama, province of Awa in Honshû.
2. Seto Peninsula, province of Kii in Honshû.
3. Uranouchi-mura, Takaoka-gun, Province of Tosa in Shikoku.
4. Fukushima, Seto-mura, Nishi-Sonogi-gun, Province of Hizen in Kyûshû.
5. Kaikô, Chôshû-gun, province of Takao in Taiwan.

1. *Antillia*, DUNCAN

Antillia is one of the interesting coral genera; it has one species living in the West Indies and several in the Pacific, while early forms are well represented in the Miocene and in later deposits of the West Indies and of the Pacific region.

The genus was established in 1864 by P. M. DUNCAN[1] from the Miocene of the West Indies on the genotype *Montlivaultia ponderosa* M.-EDW. and HAIME; its original generic diagnosis is:

"Coral simple, with more or less dentate septa, a columella, an epitheca, and both an endotheca and exotheca. Costae variously granulated, tuberculated, spined or crested."

Besides the genotype, the author described three other species of the genus, all from the Miocene of the West Indies: they are *Antillia dentata*, DUNCAN,[2] *Antillia lonsdaleia* DUNCAN,[3] and *Antillia bilobata* (DUCHASSAING).[4] The last species was originally assigned by DUCHASSAING[5] to *Turbinolia*.

Soon afterward the same author reported concerning a variety of *Antillia lonsdaleia* living at no great depth in the Japanese seas.[6] "It was sent over by Captain ST. JOHN and on examining the two specimens I could not distinguish a specific difference between them and the fossil form. The arrangement of the lobed septa, their high calicinal number, their ornamentation and endotheca are most close in their resemblance. The general shape differs a little and the compressed form of calice constitutes a variety only."

The generic diagnosis was revised in 1877 by F. BRÜGGEMANN[7] as follows:

"Coral short, turbinate, in the earliest stages fixed to the ground by a short pedicel, afterwards free, pointed at its base. Epitheca well developed, moderately appressed, generally with transverse ringlets of growth. Costae prominent, equal, denticulate. Calicle more or less oblong, with a longer and a shorter axis. Septa much projecting, rounded at their summits, with their free inner edges uniformly and minutely serrato-dentate; the inner thirds of the larger septa sometimes separated by an emargination as paliform lobes. Columella large, oblong, spongious."

At the same time he enumerated four living species of the genus, namely:—

Antillia lonsdaleia DUNCAN var.[8]	Japanese seas; in moderate depth.
Antillia explanata (POURTALES)[9]	Barbadoes; in 75 fathoms.
Antillia geoffroyi (AUDOUIN)[10]	Red Sea.
Antillia constricta BRÜGGEMANN[11]	Borneo.

Later described by J. S. GARDINER[12] from the waters of the Maldive Archipelago is

Antillia constricta BRÜGGEMANN var. *maldivensis* GARDINER

and the addition of this name to the above list makes it complete to cover all the living species of the genus previously described.

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[1]P. M. DUNCAN: On the Fossil Corals of the West Indian Islands. Part 11. Quart. Jour. Geol. Soc. London, Vol. XX, 1863, p. 28.
[2]P. M. DUNCAN: *Op. cit.*, p. 29.
[3]P. M. DUNCAN: *Op. cit.*, p. 30.
[4]P. M. DUNCAN: *Op. cit.*, p. 31.
[5]J. FELIX: Fossilium Catalogus, Animalia, pars 35, Anthozoa Miocaenica, 1927, p. 309.
[6]P. M. DUNCAN: Notices of Some Deep-sea and Littoral Corals from the Atlantic Ocean, Caribbean, Indian, New Zealand, Persian Gulf, and Japanese, etc. Seas. Proc. Zool. Soc. London, 1876, pp. 428 and 433.
[7]F. BRÜGGEMANN: Notes on Stony Corals in the Collection of the British Museum. Ann. a. Mag. Nat. Hist., Vol. XX, 1877, p. 307.
[8]F. BRÜGGEMANN: *Op. cit.*, p. 307.
[9]F. BRÜGGEMANN: *Op. cit.*, p. 308.
[10]F. BRÜGGEMANN: *Ibid.*
[11]F. BRÜGGEMANN: *Op. cit.*, p. 309.
[12]J. S. GARDINER: The Fauna and Geography of the Maldive and Laccadive Archipelagoes, Vol. II, 1906, p. 758, Pl. LIX, Figs. 4-5.

Fossil species are more numerous,[1] those previously described being listed below; the list contains one living species and one living variety which are also found as fossils.

Antillia bullbrooki HOFFMEISTER[2]	West Indies; Miocene.
Antillia constricta BRÜGGEMANN[3]	Borneo; Pleistocene.
Antillia cristata GERTH[4]	Borneo; Miocene
Antillia dentata DUNCAN	West Indies; Miocene.
Antillia dubia DUNCAN[5] (originally described as *Flabellum*)	West Indies; Miocene.
Antillia grandiflora GERTH[6]	Java; Pliocene.
Antillia guesdesi (DUCHASSAING and MICHELLOTTI)[7] (originally described as *Montlivaultia*; synonym:–*Antillia bilobata* (DUNCAN), originally described as *Turbinolia*)	Florida; Oligocene. West Indies; Miocene.
Antillia infundibuliformis GERTH[8]	Java, Pliocene.
Antillia lonsdaleia DUNCAN	West Indies; Miocene.
Antillia orientalis GERTH[9]	Java and Borneo; Miocene.
Antillia ponderosa (DUCHASSAING) (originally described as *Montlivaultia*)	West Indies and India; Miocene. West Indies; Pliocene and Pleistocene (?)
Antillia cfr. *ponderosa* M.-EDW. and H.	Ceram; Pliocene or Pleistocene.
Antillia sawkinsi VAUGHAN[11]	West Indies; Miocene.
Antillia turbinata GERTH[12]	Borneo and Sumatra; Miocene. Nias; Neogene.
Antillia walli DUNCAN[13]	West Indies; Miocene and Pleistocene (?)

[1]There are a number of species occasionally assigned to the genus, but now excluded from it by us; these are, for instance,

Circophyllia clevei DUNCAN	West Indies; Eocene.
Circophyllia compressa DUNCAN	West Indies; Eocene.
Circophyllia cylindrica REUSS	Italy; Oligocene.
Antillia dominicensis VAUGHAN	West Indies; Miocene.
Antillia indica DUNCAN	India; Miocene.
Antillia lens DUNCAN	South Australia; Miocene.
Antillia plana DUNCAN	India; Miocene.

On the other hand, the next two species

Antillia dentata DUNCAN	West Indies; Miocene.
Antillia ponderosa M.-EDW. and H.	West Indies; Pliocene.

are regarded by us as typical *Antillia*, though T. W. VAUGHAN once transferred them to the genus *Syzygophyllia* (T. W. VAUGHAN: Contributions to the Geology and Palaeontology of the Canal Zone Panama, 1919, p. 214).

[2]T. W. VAUGHAN and J. E. HOFFMEISTER: Miocene Corals from Trinidad. Carnegie Inst., Washington, 1925, p. 119, Pl. II, Figs. 7, 8.

[3]H. GERTH: Die Anthozoenfauna des Jungtertiärs v. Borneo. Samml. d. Geolog. Reich, Mus. Leiden, Ser. 1, Bd. X, 1923, p. 66, Pl. IV, Figs. 2, 3.

[4]H. GERTH: Jungtertiäre Korallen von Nias, Java und Borneo, Nebst einer Uebersicht über die aus dem Känozoikum des Indischen Archipels Bekannten Arten. Leid. Geol. Mededeelingen, XI, 1925, p. 44, Pl. VII, Fig. 3.

[5]P. M. DUNCAN: On the Fossil Corals of the West Indian Islands. Part 1. Quart. Journ, Geol. Soc. London, Vol. XIX, 1863, p. 429.

[6]H. GERTH: Coelenterata, Anthozoa. Samml. d. Geol. Reichs.-Mus. Leiden. N. F. Bd. I, 2te Abt., H. III, 1921, p. 409, Pl. LV, Figs. 8, 9.

[7]J. FELIX: *Op. cit.*, p. 309. P. M. DUNCAN: *Op. cit.*, Part 11, p. 31, Pl. III, Fig. 3.

[8]H. GERTH: *Op. cit.* (1921), p. 408, Pl. LV, Fig. 10.

[9]H. GERTH: *Op. cit.* (1923), p. 67, Pl. IV, Fig. 2.

[10]J. H. F. UMBGROVE: Report on Plistocene and Pliocene Corals from Ceram. in L. Rutten and W. Hotz's Geological Petrographical and Palaeontological Results of Explorations, carried out from September 1917 till June 1919 in the Island of Ceram. 1924, p. 7, Pl. II, Figs. 3, 4.

[11]T. W. VAUGHAN and J. E. HOFFMEISTER: *Op. cit.*, p. 118, Pl. II, Fig. 6.

[12]H. GERTH: *Op. cit.* (1925), p. 43, Pl. 7, Fig. 2. J. H. F. UMBGROVE: Neogene en Pleistoceene Koralen van Sumatra. Wet. Med Diest Mijnb. Nederl.-Indié. No. 4, 1926, p. 32, Pl. I. Fig. 4.

[13]P. M. DUNCAN and G. P. WALL: A Notice of the Geology of Jamaica, especially with Reference to the District of Clarendon; with Description of the Cretaceous, Eocene, and Miocene Corals of the Islands. Quart. Journ. Geol. Soc. London, Vol. XXI, 1864, p. 11, Pl. II, Fig. 4.

Some of the specific and varietal names cited above need alteration. *Antillia lonsdaleia* DUNCAN var. living in the Japanese seas is considered by us to be specifically distinct from the West Indian species, and a new name *duncani* is here proposed for it. *Antillia constricta* described by GERTH from the Pleistocene of Borneo is referable to its variety *maldivensis* while *Antillia infundibuliformis* GERTH from the Pliocene of Java is indistinguishable from *Antillia constricta* BRÜGEMANN, as is explained later on.

The number of the living and extinct species is now enlarged by our present study of Japanese materials. Five species and one variety are distinguished in our living and semifossil specimens; they are:

Antillia constricta BRÜGGEMANN	Noma; semifossil.
Antillia constricta var. *kiiensis* nov.	Kii; living.
Antillia duncani nov. nom.	Japan; living.
Antillia flabelliformis nov. sp.	Kôchi; living.
Antillia japonica nov. sp.	Noma; semifossil.
Antillia nomaensis nov. sp.	Noma; semifossil.

In all, there are 10 species and varieties found either living or as semifossil in the world, of which one each is in the Atlantic Ocean, the Red Sea and the Indian Ocean. All the others are from the part of the Pacific Ocean ranging from the Japanese seas to the Malay Archipelago, and the Japanese seas seem to be the center of the present geographical distribution of the genus; it is very likely that more new forms will be found in this part of the Pacific Ocean in the future.

There are rather few records of the occurrence of species of *Antillia* in Pleistocene and Pliocene deposits; on the other hand, a great many species are known from Miocene, and especially the Miocene deposits of the West Indies are exceedingly rich in them. This genus certainly flourished most in this geological period.

No definite statement can be made of the early history of the genus in the Pacific Ocean, until the constitution of the Palaeogene and Neogene coral faunas of Japan and the Philippines is fully known.

The genus *Antillia* is used in different senses by different authors and there are several allied genera from which its distinction is by no means easy. It is very similar to *Montlivaultia*[1] (LAMOUROUX, 1821) in general aspect of corallum, but it possesses spongious columella, while *Montlivaultia* is quite free from columella. In *Syzygophyllia*[2] (REUSS, 1872), corallum is nearly cylindrical, calicular fossa very shallow, columella rather narrow and circular in cross section, and the septa of the younger cycles bend toward and coalesce with the adjacent ones of the older cycles along their inner margins; otherwise there does not exist any essential distinction between them. It is noteworthy that in a certain species of *Antillia*, the septa show a similar tendency especially in the interior of the corallum, though usually free in their inner margin, where well preserved, on the calicular surface. *Homophyllia*[3] (BRÜGGEMANN, 1877) has cylindrical corallum and narrow spongy circular columella in common with *Syzygophyllia*, and deeper calicular fossa as well as free septa in common with *Antillia*, being distinguished from the two genera by the

[1]MILNE EDWARDS et J. HAIME: Histoire naturelle des Coralliaires ou Polyps Proprement ditto., Vol. II, 1860, p. 296. J. FELIX: *Op. cit.*, p. 307.

[2]A. E. REUSS: Die Fossilen Korallen des Osterreichisch-Ungarischen Miocäns. Sitz.-Ber. d. k. Akad. d. Wiss. Wien. Mat.-Nat. Cl., Vol. XXXI, 1872, p. 232.

[3]F. BRÜGGEMANN: *Op. cit.*, p. 310.

epitheca. *Cynarina*[1] (BRÜGGEMANN, 1877) which most resembles *Antillia* differs from it in having "calicular fossa very shallow, the calice circular in the adult, compressed in the young (the reverse being the case in *Antillia*)," finally, *Lithophyllia*[2] M-EDW. and H., 1957), including *Scolymia*[3] (BRÜGGEMANN, 1877) and *Circophyllia*[4] (M.-EDW. and H., 1848) are distinguished from *Antillia* by the absence of epitheca or rudimentary epitheca, shallow calicular fossa, and more or less circular calice and columella.

With the qualifications cited above, the generic diagnosis of *Antillia* is now revised as follows:

Coral simple. Adult corallum turbinate to subcylindrical, bilateral; and often medially constricted; attached to the substratum by a pointed base in turbinate forms and by a broad base in subcylidrical forms. Epitheca well developed, moderately appressed, generally with transverse ringlets of growth; outgrowing and serving for attachment of the corallum to the substratum in subcylindrical forms. Costae prominent, equal to subequal, denticulate. Calice moderately to very deep, more or less oblong, with a longer and a shorter axis; much elongated in certain species. Septa very exsert, rounded at their summits, with their free inner edges uniformly and minutely serratodentate; the inner part of the larger septa sometimes separated by an emargination as paliform lobes; in the interior of corallum of certain species, septa of the younger cycles bending toward and coalescing with the adjacent ones of the older cycles. Septal surface minutely granulated, granules often arranged in divergent rows running to the marginal teeth. Columella large, elongated, spongious. Dissepiments vesicular, rather few.

In the earliest stages of growth, corallum nearly circular and discoidal, fixed to substratum by a short pedicle; columella narrow and circular in cross section.

Antillia constricta BRÜGGEMANN

Pl. XXXVIII (II), Figs. 5, 6.

var. kiiensis nov.

Pl. XXXVII (I), Figs. 5, 6.

1877. *Antillia constricta* BRÜGGEMANN: *Op. cit.*, p. 309.
1906. *Antillia constricta* BRÜGG. var. *maldivensis* GARDINER: *Op. cit.*, p. 757, Pl. LIX, Figs. 4, 5.
1921. *Antillia infundibuliformis* GERTH: *Op. cit.*, p. 408, Pl. LV, Fig. 10.
1923. *Antillia constricta* GERTH: *Op. cit.*, p. 66, Pl. IV, Figs. 2, 3.

"Coral short, turbinate, straight, with pointed base, apparently free. Calicle much longer than broad, oblongo-elliptical, with the sides in the middle deeply and regularly constricted in the direction of the short axis, giving to the outline nearly the shape of an 8; each of the four corners with a very slight indication of an additional constriction. Epitheca well developed, covering half the height of the wall; the latter rather thin with scanty but conspicuous exotheca. Costae subequal, prominent, almost cristiform, their edges with a single series of crowded small and acute teeth. Edge of the calicle not on the same level, much elevated in the constricted middle part, lowest at the extremities of the long axis. Fossa deep. Septa most regular, belonging to six,

[1]F. BRÜGGEMANN: *Op. cit.*, p. 305.
[2]MILNE EDWARDS and HAIME: *Op. cit.*, p. 290.
[3]F. BRÜGGEMANN: *Op. oit.*, p. 301.
[4]MILNE EDWARDS and HAIME: *Op. cit.*, p. 293.

complete cycles: primary, secondary, and tertiary ones subequal, thick, well projecting, obtusely rounded on their summits, their lateral surfaces covered with remote granules, which are arranged towards the inner edge in oblique rows running to the marginal teeth; their free inner edges in the upper half straight, with small crowded acute teeth, then suddenly dilated to a large paliform lobe, which is separated by a deep, acute or rectangular emargination, and has its edge entire. Septa of fifth and sixth cycles lacerately toothed, without paliform lobes. Columella well developed, linear in outline, with even, more papillose than spongious surface, dense, consisting of thin, filiform, subparallel trabeculae, most of which are evenly furcate at the top. Height of coral 40 mm., longer axis of calicle 65 mm., shorter axis 45 mm., shortest diameter (in the constricted middle parts) 25 mm."

The above description of *Antillia constricta* was given by BRÜGGEMANN based on a single adult specimen from Borneo; he assigned to the same species also two more specimens derived from North Australia.

Subsequently GARDINER distinguished var. *maldivensis* from the species on the basis of his specimens from the waters of the Maldive Archipelago, since they possess spongious columella with rather papillose surface.

It seems to us that *Antillia constricta*, the type example, possesses septa in six cycles, while var. *maldivensis* has them in seven cycles, and that this difference is independent of the individual growth stage.

Antillia infundibuliformis GERTH from the Pliocene of Java—which was first considered by GERTH as a distinct species allied with *Antillia geoffroyi* (AUDOUIN) and *Antillia constricta* var. *maldivensis*—was later withdrawn by the author himself, this as well as var. *maldivensis* being thought not worthy of specific separation from *Antillia constricta*, as the varied aspect of columella is more apparent than real, much depending on different states of preservation. It is highly probable that *Antillia infundibuliformis* is based on an inmature specimen of *Antillia constricta* and differs from var. *maldivensis* in having less numerous septa, while *Antillia constricta* of GERTH from the Pleistocene of Borneo with more numerous septa, is identical with var. *maldivensis*.

In our material, there is one recent specimen which is conical in the basal one third of the height of the corallum and cylindrical in the upper part and thus is quite different in general shape from the others; this specimen being otherwise indistinguishable from the typical *constricta*, is considered by us as a new variety of this species under the name *kiiensis*.

The annexed table brings the features essential to each of *Antillia constricta*, var. *maldivensis* and var. *kiiensis* into comparison.

Var. *kiiensis* nov. is characterised as follows:

Corallum rather tall, conical in the lower part and cylindrical in the middle and upper parts; medially constricted and bilobate. Calice much longer than broad and "8" shaped. Epitheca well developed, covering about five-sixths of the height of the outer surface. Calicular fossa deep. Septa much exsert, 175 in number and in six cycles, of which the sixth cycle is incomplete. Columella well developed, narrow and long, being 30 mm. × 3 mm. in dimensions; spongious. Emargination and marginal dentation of septa, and granulation of their lateral surface as in the typical species.

Antillia constricta

Specimens examined:

Noma near Tateyama, province Awa in Honshû; semifossil. 2 specimens (Reg. Nos. 38559, 38578).

Name	*constricta*	*kiiensis*	*maldivensis*		*constricta*	*maldivensis*[1]	*constricta*
Locality	Japan		Suvadiva; recent		Borneo		Java; Pliocene
	Noma; semifossil	Kii; recent			Recent	Pleistocene	
Figure	Y. & S. II, 5–6	Y. & S. I, 7–8	GARDINER LIX, 4(lower)	GARDINER LIX, 4(upper), 5	BRÜGGEMANN P. 309	GERTH IV, 2–3	GERTH I, 10
Shape	turbinate	conico-cylindrical	turbinate	turbinate	turbinate	turbinate	turbinate
Number of the cycles of septa	6	6	7	7	6	7	6
Total number of septa	177	175	214+	212+	?	310+	113+
Longer axis of calice (mm.)	85	82	75	74	65	90	50
Shorter axis of calice (mm.)	60	55	43	48	45	63	40?
Shortest axis of calice (mm.)	35	30	19	18	25	21	15
Height of corallum	50	68	57	52	40	75	35
Depth of fossa	27	25	20	20	deep	deep	deep

[1]*Antillia constricta* of GERTH.

Other occurrences:

Borneo (living); South Australia (living); Java (Pliocene).

Antillia constricta var. *maldivensis*

Occurrences:

Suvadiva, Maldive Archipelago (living); Borneo (Pleistocene).

Antillia constricta var. *kiiensis*

Specimens examined:

Seto Peninsula, province of Kii; living. 1 specimen (Reg. No. 38745).

Antillia flabelliformis nov. sp.

Pl. XXXVIII (II), Figs. 7, 8.

Corallum flabelliform with narrow base bluntly pointed; nearly semicircular in side view. Calice linear, rounded at both extremities, with a broad medial constriction in one side and two shallow ones on the other; calicular fossa deep. Epitheca covering about three-fourths of the height of the outer surface. Exotheca and endotheca moderately developed. Costae subsequal, prominent, cristiform, with a single series of crowded small acute teeth, 10–12 in 2 mm., on their edges. Septa 154 in number, arranged in six cycles; sixth cycle incomplete. All the features of septa as in the preceding species, excepting paliform lobes which are somewhat indistinct. Columella well developed, linear, consisting of thin filiform trabeculae furcate at the top.

Height of the corallum 55 mm.; longer axis of calice 93 mm., shorter axis of the same 20 mm.; fossa 20 mm. deep; columella 3×55 mm.

Specimen examined: Uranouchi-mura, Takaoka-gun, province of Tosa; living. 1 specimen (Reg. No. 38519).

Antillia japonica nov. sp.

Pl. XXXVII (I), Figs. 1-4; Pl. XXXVIII (II), Figs. 1, 2.

Corallum short, subcylindrical, slightly compressed, attached to the substratum with broad flat base. Calice subelliptical-subquadratic, longer than broad; calicular fossa relatively shallow; calicular margin lying in a plane slightly elevated along the short axis. Epitheca covering about three-fourths of the height of the outer surface, mostly worn out and leaving only strong, rather distant ringlet lines. Endotheca moderately developed; exotheca less. Costae thick, subequal, prominent, with their obtuse edge tuberculated in number of 4-5 in 10 mm. Septa not much exsert, 96 or less in number and arranged in five cycles, of which the fifth cycle is incomplete. Primary, secondary and tertiary septa subequal, all reaching to columella; obtusely edged, edges coarsely dentated, teeth of the upper margin large, prominent and usually triangular, becoming sharper toward the periphery of the calice. Quartery septa nearly as long as those of the earlier cycles, but decidedly thinner; septa of the fifth cycle much shorter; those of the fourth and fifth cycles minutely toothed along their edge. In the interior of the corallum, the inner margin of the septa of the younger cycles bending toward and coalescing with the earlier ones, though they are almost always free on the calicular surface. Septa and costae granulated all over, granules minute, rounded and crowded irregularly. Paliform lobes somewhat distinctly developed in the septa situated near the two extremities of the longer diameter of the calice. Columella well developed, linear, spongious, consisting of thin filiform trabeculae mostly furcate at the top.

Five specimens now at our disposal are measured below (in mm.):

	A	B	C	D	E
Number of septa	96	96	73	70	75
Longer diameter of calice	80	65	48	40	45
Shorter diameter of calice	55	60	30	20	30
Height of the corallum	45	68	45	20	35

Specimens examined: Noma near Tateyama, province of Awa in Honshû; semifossil. 5 specimens (Reg. Nos. 38554, 7161).

Antillia nomaensis nov. sp.

Pl. XXXVIII (II), Figs. 3, 4.

Very like the preceding species. Corallum short, subcylindrical, sessile with broad flat base. Calice rather shallow, subcircular, with a slight constriction. Epitheca covering about three-fourths of the height of the outer surface, but mostly worn off. Endotheca moderately developed; exotheca less. Costae subequal, tuberculated along their margin; tubercles spacedat the rate of about in 10 mm. and becoming prominent towards the calicular margin. Septa 110 in

number, arranged in six cycles, of which the sixth cycle is incomplete. Primary and secondary septa subequal, relatively thick, much projecting, obtuse on their summits; free edge coarsely toothed. Septa of the third and fourth cycles nearly as long as the earlier ones; those of the sixth cycle shorter; all these much thinner than the earlier ones. Septa of all the cycles minutely granulated all over the surface; granules minute, and scattered without order; younger septa often coalescing with the earlier ones along their inner margin a feature which is visible on the calicular surface. Paliform lobe not distinct. Columella large and elliptical, consisting of trabeculae rather lamellar than filiform and mostly furcated at the top. Height of corallum 25 mm., longer axis of calice 48 mm., shorter axis of the same 35 mm.; calicular fossa about 6 mm. in depth.

Remarks: The present species much resembles the preceding one, but differs from it in having septa one more cycle and in lacking a distinct paliform lobe, and in bearing a different columellar character.

Specimen examined: Noma near Tateyama, province of Awa in Honshû; semifossil. One specimen (Reg. No. 38555).

Antillia duncani nov. nom.

1876. *Antillia lonsdaleia* var. DUNCAN: Op. cit., p. 438, Pl. XLI, Figs. 1-2.

We have no specimen of this species at our disposal now. The specimen, which was obtained in the Japanese seas and illustrated by DUNCAN as a variety of *Antillia lonsdaleia* DUNCAN, is apparently too different from the type of the West Indian Miocene species for to justify this treatment: first, the corallum in the Japanese form is broadly conical, much broader than high, the ratio of its height to the longer diameter of the calice being 13: 17. On the contrary in *A. lonsdaleia*, the corallum is considerably taller, the same ratio being 11: 7. Secondly: the septa are apparently very exsert in the Japanese form while they are less so in the Miocene species. Thirdly: epitheca is less developed in the Japanese form, covering only half the height of the outer surface of the corallum, while it extends almost to the very calicular border in the Miocene species.

Probably there may exist more differences between them, but it is not possible to point them out at this place without comparing the actual specimens of the two. It must, however, be added that there are two other circumstances in favour of the specific separation of the two: 1) the geographical distribution of the two is quite different, one occurring in the West Indies and the other in the North Pacific, and 2) geologically the two are quite far apart, one being found in Miocene deposit and the other now living.

The recent Japanese form should be distinguished as *Antillia duncani* in honour of Dr. DUNCAN who established the genus and first made known the living example of the genus in the Japanese seas;

2. *Caulastraea*, DANA

The genus *Caulastraea* was established by J. D. DANA[1] in 1846 on three living species, two (*Caulastraea furcata* DANA and *Caulastraea distorta* DANA) from the Fiji Islands and another (*Caulastraea undulata* DANA) probably from the West Indies.

[1] J. D. DANA: Synopsis of the Reports of Zoophytes of the U. S. Exploring Expedition, 1838-1842, 1846, p. 22.

The original generic diagnosis by DANA of *Caulastraea* runs as follows:

"Segregato-gemmate, cespitose, with the stems and calicles subcylindrical. Coralla fragile, exterior striate, sometimes denticulate; cell nearly orbicular, broadly excavate; lamellae unequally exsert, subentire, very numerous."

Eusmilia is a genus founded by MILNE EDWARDS and HAIME[1] two years later on *Eusmilia fastigiata* (PALLAS) from the West Indian seas and they expressed the opinion in 1857 that their *Eusmilia* does not essentially differ from *Caulastraea*.

DUNCAN[2] on the other hand held a different view in this connection, taking *Caulastraea* as a subgenus under *Eusmilia*. On the other hand, QUELCH[3] who did not recognise any essential difference between *Caulastraea* and *Eusmilia* naturally tended to accept the former as a valid generic name according to the law of priority. According to QUELCH, *Caulastraea distorta* DANA is also living in the sea of Tongatabu of the Fiji Group.

In 1921, FELIX[4] recorded a fossil species *Caulastraea leptoclada* FELIX from the Pliocene of East Borneo.

As to the relation of *Caulastraea* and *Eusmilia*, it is sometimes maintained that the latter has the septa entire or subentire and costae less prominent than in the former, which has septa distinctly denate along their margin. Such slight difference in these particulars, however, does not seem to us to be sufficient for the generic or even subgeneric separation of the two, as already pointed out by QUELCH and others.

So far as we are now aware, species previously recorded of the genera *Caulastraea* and *Eusmilia* are few in number. There are two living and one fossil species in the Pacific, as cited above, and two living species, *Eusmilia fastigiata* (PALLAS)[5] which is also found in Pleistocene deposits and *Eusmilia silene* (DUCHASSAING and MICHELOTTI),[6] and one fossil species, *Eusmilia carrizensis* VAUGHAN[7] in the Atlantic; besides, there are two living species of uncertain habitat, *Eusmilia alticostata* M.-EDW. and H.[8] and *Caulastraea undulata* DANA,[9] both imperfectly known in regard to their specific features. All of the Pacific species are also not yet fully described in regard to their specific features, being neither sufficiently illustrated not based on good specimens. This circumstance renders the specific determination of our specimens somewhat difficult; but after careful examination and contemplation, we deem it inevitable to establish three new species and one new veriety which are named as follows:

Caulastraea yokoyamai sp. nov.
Caulastraea yokoyamai var. *gracilis* nov.
Caulastraea multiseptata sp. nov.
Caulastraea? *gigantea* sp. nov.

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[1] M. EDWARDS and HAIME: *Op. cit.*, p. 186.
[2] P. M. DUNCAN: A Revision of the Families and Genera of the Sclerodermic Zoantharia, Ed. and H., or Madreporaria. Journ. Linnean Soc. London. Zoology Vol. XVIII, 1884, p. 77.
[3] J. J. QUELCH: Report of the Reef Corals. Challenger Reports, Zool. Vol. XVI, No. 3, 1886, p. 74.
[4] J. Felix: Fossile Anthozoën von Borneo. Paläont. v. Timor, Lief. IX, 1921, p. 24, Pl. CXLII, (2), Figs. 10, 10 a–b.
[5] MILNE EDWARDS and HAIME: *Op. cit.*, 187. T. W. VAUGHAN: *Op. cit.*, p. 361. The Reef-Coral Fauna of Carrizo Creek, Imperial County, California and its Significance. U. S. Geol. Surv. Prof. Pap. 98-T, 1917, p. 369.
[6] J. FELIX: *Op. cit.* (1921), p. 23.
[7] T. W. VAUGHAN: *Op. cit.* (1917).
[8] J. D. DANA: *Op. cit.* MILNE EDWARDS and HAIME: *Op. cit.*, p. 189.
[9] MILNE EDWARDS and HAIME: *Op. cit.*, p. 188. J. FELIX: *Op. cit.* (1921).

Caulastraea yokoyamai nov. sp.

Pl. XXXIX (III), Figs. 1-4.

Form of an entire colony unknown, all the specimens at hand being fastigiate narrow columns, broken at the posterior end and often over 180 mm. long. Columns sometimes a little flexuous; repeatedly dichotomously branching by fission. Fission usually taking place at a distance of 30-50 mm., but seldom very close and then giving rise to apparent trichotomy. Branches ascending, mostly subparallel or at least never much diverging, though branching happens in an initial angle 10°-35° and sometimes even up to 50°. Each branch or corallite subcylindrical, 18 mm. or less in diameter, elliptical to subcircular in cross-section, broadened and more or less flattened toward the end of the branches where fission begins; often ending tumid at the top where the calices are elongated or bilobed by the beginning of fission. Outer surface of the corallum longitudinally costated; costae numbering 4-5 in 5 mm., prominent, and sometimes up to 1 mm. blunt on top, finely toothed; teeth on costae rather blunt, oblique, and numbering 10-15 in 10 mm. Epitheca thin and indicated only by very distant elevated irregular ringlet lines. Endotheca well developed. Circular calice 8-10 mm. in diameter, becoming larger and much elongated up to 20 mm. before fission; subelliptical ones after fission being 8×10 mm.-10×12 mm. in size. Calicular fossa deep, 5-8 mm. in depth. Septa exsert, mostly regular, 28-48 in number and arranged in four cycles; primary and secondary septa subequal, rather thick, obtusely rounded on their summits, most of them extending to columella; those of the third cycle nearly as long as the earlier ones, but slender; some reaching to columella and the others shorter. All the septa spinulated along the margin; lateral surfaces covered with remote granules which are usually arranged towards the margin in oblique rows running to the marginal teeth, or sometimes arranged rather irregularly. Inner margin of the septa of early cycles showing tendency to form paliform lobe by emargination; divided in its lower part into flexuous and furcate filiform processes which anastomose to build a kind of columella.

Remarks: This is a very common form in the raised coral bed of Noma, and *Thecosmilia* sp. of Dr. YOKOYAMA is probably this species, which is superficially very similar to the genus.

It resembles *Caulastraea furcata* DANA from the Fiji Islands, which is described by DANA[1] as follows:

"Stems straight, furcating, scarcely undulate, 3-5 lines thick; disk of polyps bright green. Corallum everywhere obtusely striate, smooth; branchlets 1-2 inches long, alive for 4-6 lines; calices often a little tumid, elliptical or orbicular; lamellae numerous, 1 line exsert, subentire, subequal, usually narrowing upward."

Evidently DANA's species is smaller in form and the corallum is ornamented exteriorly by smooth costae and provided with septa which are subentire along the margin. Our form is larger, bearing costae denticulated and septa spinulated along the margin. The two are sufficiently distinct specifically.

The specific name is dedicated to Dr. M. YOKOYAMA, formerly Professor of Palaeontology, University of Tôkyô, to whom we are indebted for numerous valuable papers on Cenozoic Molluscan faunas.

Specimens examined: Noma near Tateyama, province of Awa, Honshû: semifossil. Very numerous (Reg. No. 38537).

Seto Peninsula, province of Kii; living, 1 specimen (Reg. No. 36911).

[1] J. D. DANA: *Op. cit.*

Caulastraea yokoyamai var. **gracillis** nov. var.

Pl. XXXIX (III), Figs. 9–14.

Corallites slender, 8–13 mm. and rarely up to 15 mm. in diameter; costae thin, wide spaced, numbering 5–6 in 5 mm.; finely toothed. Calice roundish, 7–10 mm. in diameter; septa 20–45 in number, 6–18 of them extending to columella.

Distinguished from the typical species by slender corallites with somewhat remote costae, which are relatively thin or acute.

This form is also richly represented in our collection of semifossil corals from Noma, though less common than the typical species. By its slender corallites it more nearly approaches *Caulastraea furcata* DANA.

Specimens examined: Noma near Tateyama, province of Awa in Honshû; semifossil. Numerous specimens (Reg. No. 38744).

Seto Peninsula, province of Kii; living. 1 specimen (Reg. No. 38743).

Caulastraea multiseptata nov. sp.

Pl. XXXIX (III), Figs. 5–8.

Form of an entire colony unknown, but probably forming a hemispherical clump of moderate size, which is a cluster of ascending branches or corallites repeatedly dichotomous by fission. Distance between forks 20–30 mm.; also often very close and giving rise to apparent trichotomy. Corallites diverging: expanding and at the same time flattening toward the next fork; final segments short, tumid at top and each ending in a calice which is usually flattened or sinuous owing to the beginning of the fission, and seldom roundish. Roundish calice 10–12 mm. in diameter, much elongated ones measuring 25 mm. in the longer diameter; fossa deep, being 8–10 mm. in depth. Outer surface of the corallites longitudinally costated; costae numbering 5–7 in 5 mm., prominent and finely toothed; teeth minute, pointed, numbering 7–8 in 5 mm. Epitheca thin. Endotheca well developed. Septa much exsert, 40–72 in number and arranged in 5 cycles; about 15–20 longer ones reaching to columella. Primary, secondary and tertiary septa rather thick and more projecting than the others; paliform lobes rather distinct with its inner margin divided into long furcate filiform processes which anastomose to built a kind of columella. Septa of the fourth and fifth cycles short and thin, All the surface of the septa covered with remote granules, which are usually arranged toward the margin in oblique rows running to the marginal teeth.

The type specimen is a part of a colony and is 100 mm. in height.

Remarks: The type specimen of this species from which the above description is drawn is from Seto Peninsula, province of Kii and is figured in Pl. III, Figs. 5 and 6. Compared with preceding one, it is characterised by its crowded branches, more numerous and minutely spinulate septa of usually sinuous calice, more numerous costae with narrower intervals and carrying more numerous spines. It reminds us somewhat of *Caulastraea distorta* DANA in general habit of branching, which is, however, a much smaller form, with branches 3–5 lines, 6.3–10.6 mm. in diameter.

There are, besides, several fragmental specimens of *Caulastraea* collected from the coast of Fukushima, Seto-mura, Nishi-Sonogi-gun, province of Hizen, which are built somewhat more stout, provided with prolate branches and thus intermediate between the type specimen of *Caulastraea multiseptata* and *Caulastraea yokoyamai* in growth-habitus. In number of septa and costae, the shape of calice and many other features, however, they are distinct from *Caulastraea yokoyamai* and similar to *Caulastraea multiseptata*. One of these fragments is shown in Pl. III, Figs. 7, 8.

Specimens examined:

Caulastraea multiseptata, the type. Seto Peninsula, province of Kii; living. One specimen (Reg. No. 38741).

Caulastraea cfr. *multiseptata*. Fukushima, Seto-mura, Nishi-Sonogi-gun, province of Hizen; living. Several fragments (Reg. No, 35319).

Caulastraea? gigantea nov. sp.

Pl. XXXVIII (II), Figs. 9–11.

The ill preserved fragmental specimen, here figured, exhibits all the features characteristic of the genus *Caulastraea* and represents a species distinct from all the others. It is the largest species now known, judging from the length and breadth of branching corallites.

Corallites subcylindrical, gradually expanding upwards, over 138 mm. long; forking dichotomously. Branches subparallel, approximate, subelliptical in the section, 10×15 mm. – 15×25 mm. in size. Outer surface uneven, owing to frequent nodular outgrowths; longitudinally costated; costae relatively distant, numbering 4 – 5 in 10 mm., rather obsolete, often reducing to a row of denticles; teeth coarse, set at irregular intervals and numbering 5 – 7 in 10 mm. on the average. Epitheca thin; endotheca well developed as in the two preceding species. Calicular fossa deep. Septa regular, 32 – 36 in number and arranged in four cycles; 8 – 10 of them with their filiated inner margin anastomosing to a kind of columella; lateral surface smooth?; margin unknown. Primary and secondary septa subequal, rather thick; those of the third and fourth cycles shorter.

Remarks: Wide spaced costae, which are often reduced to a row of denticles, are characteristic of the present species which can easily be distinguished from the other species by this feature alone.

Specimens examined: Kaikô, Chôshû-gun, province of Takao; semifossil. One specimen (Reg. No. 39121).

PLATE XXXVII (I)

(All figures are natural size, unless otherwise stated.)

Antillia japonica YABE and SUGIYAMA nov. sp.

Loc.: Noma near Tateyama, province of Awa in Honshû. Reg. No. 38554 A.

Fig. 1. The holotype; calicular view.

Fig. 2. The same specimen; side view.

Fig. 3. Upper part of one of the septa of the first cycle; lateral view; co, columellar side; cs, costal side. Ca. ×2.

Fig. 4. Another specimen; calicular view.

Fig. 5. The same specimen; side view.

Antillia constricta BRÜGG. var. *kiiensis* YABE and SUGIYAMA nov. var.

Loc.: Seto Peninsula, province of Kii. Reg. No. 38745.

Fig. 6. The holotype; calicular view.

Fig. 7. The same specimen; side view.

Fig. 8. Upper part of one of the septa of the first cycle; lateral view; co, columellar side; cs, costal side. Ca. ×2.

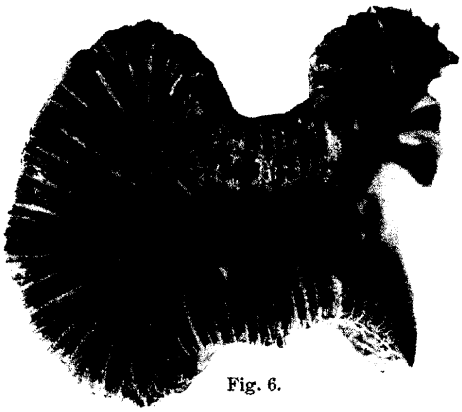


Fig. 6.

Fig. 7.

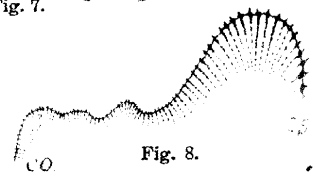


Fig. 8.

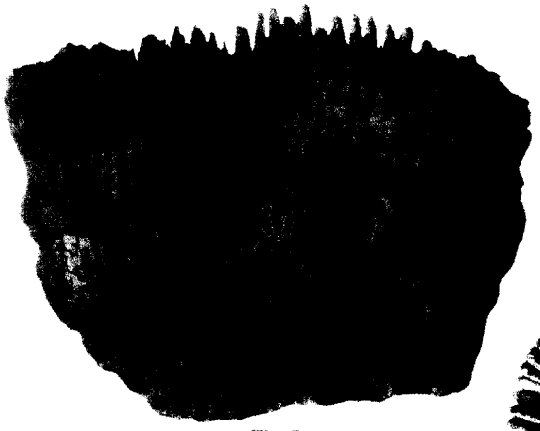


Fig. 2.

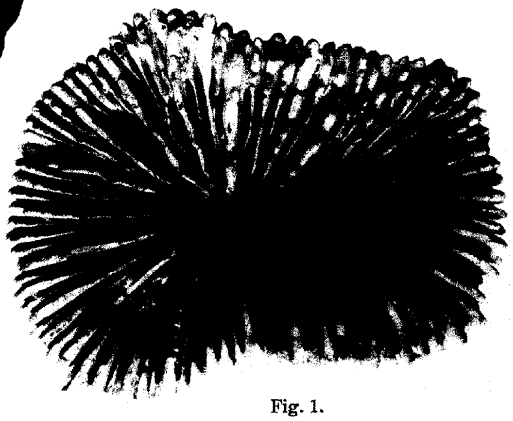


Fig. 1.

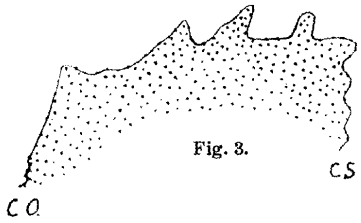


Fig. 3.

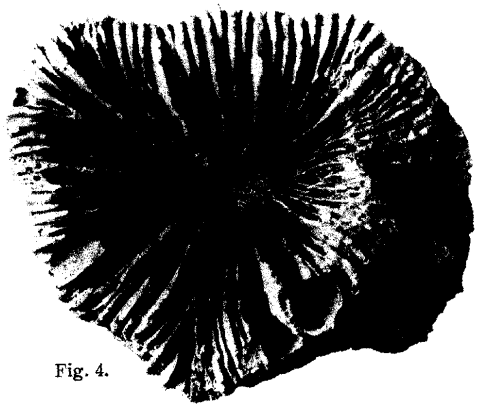


Fig. 4.

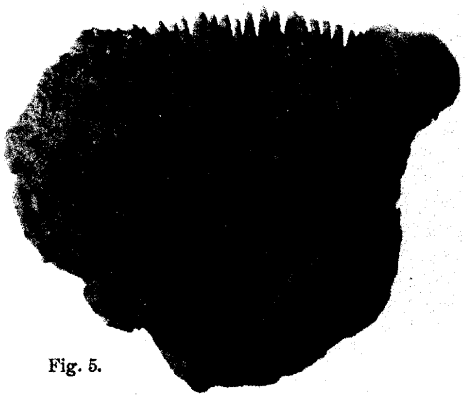


Fig. 5.

Ebina photo. and Sugiyama del.

PLATE XXXVIII (II)

(All figures are natural size, unless otherwise stated.)

Antillia japonica YABE and SUGIYAMA nov. sp.

Loc.: Noma near Tateyama, province of Awa in Honshû. Reg. No. 38554 C.

Fig. 1. Calicular view.
Fig. 2. The same specimen; side view.

Antillia nomaensis YABE and SUGIYAMA nov. sp.

Loc.: *Ibid.* Reg. No. 38555.

Fig. 3. The holotype; calicular view.
Fig. 4. The same specimen; side view.
Fig. 5. Upper part of one of the septa of the first cycle; lateral view; co, columellar side; cs, costal side. Ca. ×2.

Antillia constricta BRÜGGEMANN

Loc.: *Ibid.* Reg. No. 38559.

Fig. 6. Calicular view.
Fig. 7. The same specimen; side view.

Antillia flabelliformis YABE and SUGIYAMA nov. sp.

Loc.: Uranouchi-mura, Takaoka-gun, province of Tosa. Reg. No. 39519.

Fig. 8. The holotype; calicular view.
Fig. 9. The same specimen; side view.
Fig. 10. Upper part of one of the septa of the first cycle; lateral view; co, columellar side; cs, costal side. Ca. ×2.

Caulastraea ? *gigantea* YABE and SUGIYAMA nov. sp.

Loc.: Kaikô, Chôshô-gun, province of Takao. Reg. No. 39121.

Fig. 11. The holotype; side view.
Figs. 12 & 13. The same specimen; transverse sections.

Fig. 9.

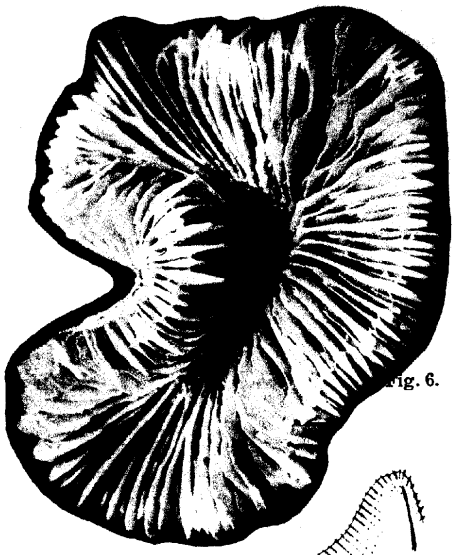


Fig. 6.

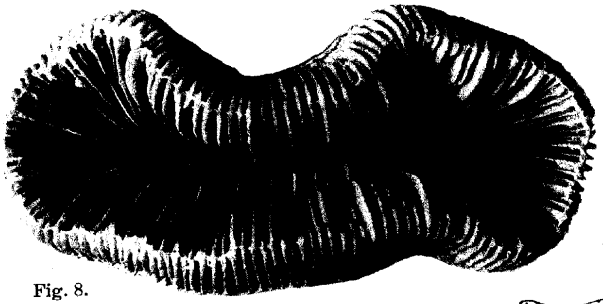


Fig. 8.

Fig. 13.

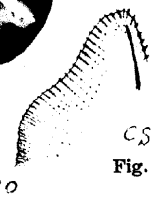


Fig. 10.

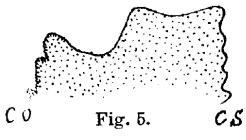


Fig. 5.

Fig. 4.

Fig. 12.

Fig. 7.

Fig. 11.

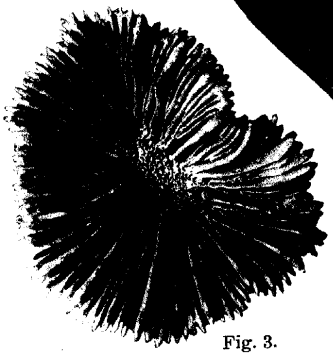


Fig. 3.

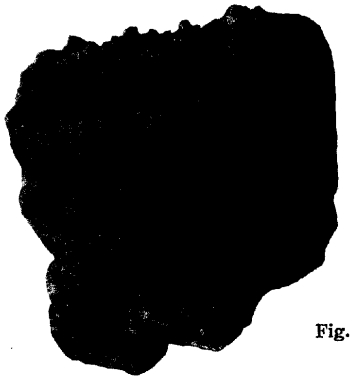


Fig. 2.

Fig. 1.

Ebina photo. and Sugiyama del.

PLATE XXXIX (III)

(All figures are natural size, unless otherwise stated.)

Caulastraea yokoyamai YABE and SUGIYAMA nov. sp.

Loc.: Noma near Tateyama, province of Awa in Honshû. Reg. No. 38537.

Fig. 1. One of the primary types; side view.
Fig. 2. The same specimen; calicular view.
Fig. 3. Upper part of one of the septa of the first cycle; lateral view; co, columellar side; cs, costal side. Ca. ×2.
Fig. 4. The second specimen of the primary types in transverse section.
Fig. 5. The third specimen of the primary types; calicular view.

Caulastraea multiseptata YABE and SUGIYAMA nov. sp.

Loc.: Seto Peninsula, province of Kii. Reg. No. 38741.

Fig. 6. The holotype; side view.
Fig. 7. The same specimen; calicular view.
Fig. 8. Upper part of one of the septa of the first cycle; lateral view; co, columellar side; cs, costal side. Ca. ×2.

Caulastraea cfr. *multiseptata* YABE and SUGIYAMA

Loc.: Fukushima, Seto-mura, Nishi-Sonogi-gun, province of Hizen. Reg. No. 35319.

Fig. 9. Side view.
Fig. 10. The same specimen; calicular view.

Caulastraea yokoyamai var. *gracilis* YABE and SUGIYAMA nov. var.

Loc.: Seto Peninsula, province of Kii. Reg. No. 38743.

Fig. 11. One of the primary types; side view.
Fig. 22. The same specimen; calicular view.

Caulastraea yokoyamai var. *gracilis* YABE and SUGIYAMA nov. var.

Loc.: Noma near Tateyama, province of Awa in Honshû. Reg. No. 38744.

Fig. 13. One of the primary types; side view.
Fig. 14. The same specimen; calicular view.
Fig. 15. The second specimen; side view.
Fig. 16. The same specimen; calicular view.

Fig. 1.

Fig. 15.

Fig. 5.

Fig. 4.

Fig. 13.

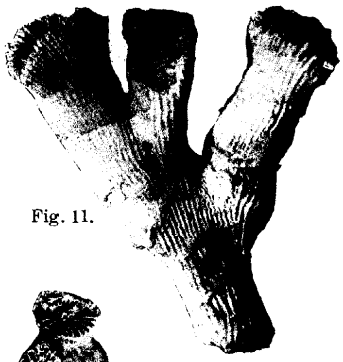
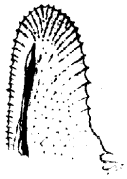


Fig. 11.

Fig. 14.



CS Fig. 3. CO

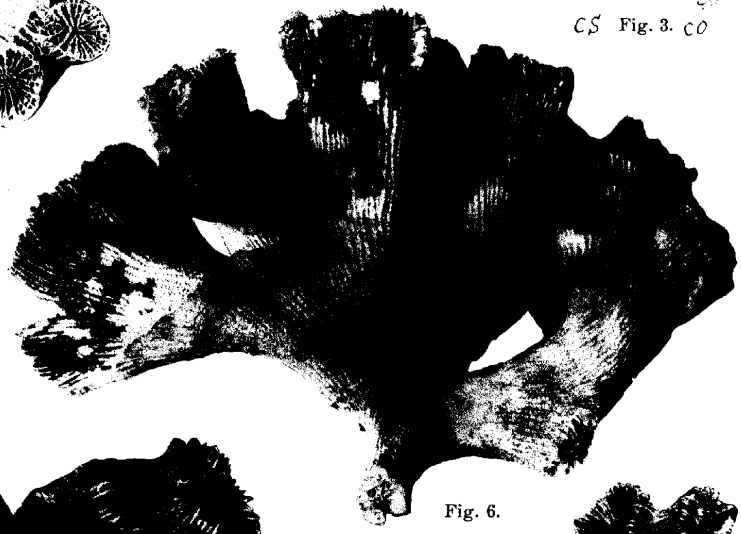


Fig. 6.

Fig. 9.

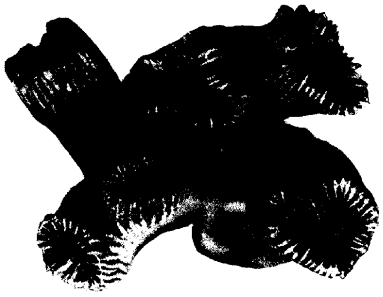


Fig. 2.

Fig. 16.

Fig. 12.

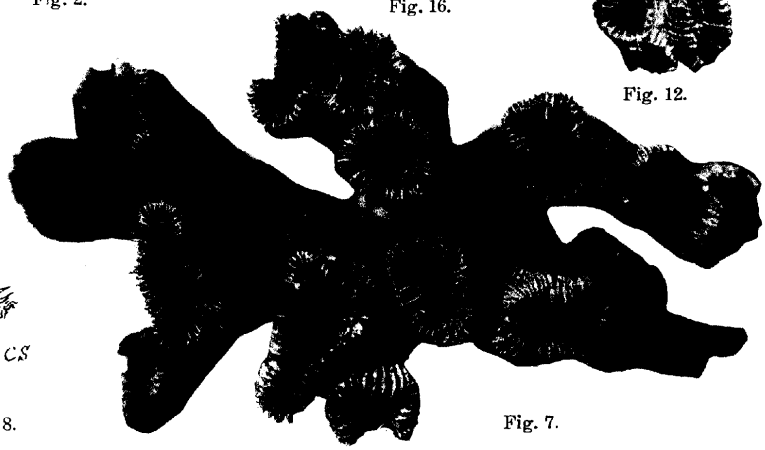


Fig. 7.

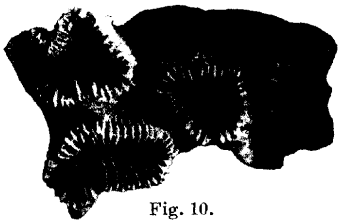


Fig. 10.

CO CS

Fig. 8.

Ebina photo. and Sugiyama del.